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To: wbol461@ecy.wa.gov
cc: gclo461@ecy.wa.gov, Kristine Koch/R10/USEPA/US@EPA
Subject: Plan for Toxicity and Analytical Testing

Wendy, Kristine and Greg:

Please find attached an advance draft of the Elwha Water Treatment Plant testing protocol as proposed by USBR Consultant, URS Corporation. If I can be of further assistance, please do not hesitate to contact me at 360-565-1324.
See you Lacy August 19th and thanks to everyone for participating and helping to find a solution to this monumental undertaking.
Dave

Draft Final Toxicity Work Plan 072103.p Dave Adkins.vcf

DRAFT FINAL REPORT

ELWHA WATER TREATMENT PLANT PREDESIGN

CLALLAM COUNTY, WASHINGTON

WORK PLAN FOR TOXICITY AND ANALYTICAL TESTING

Prepared for
U.S. Bureau of Reclamation
Boise, Idaho

July 21, 2003

URS

Mission Statements

U.S. Department of the Interior

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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List of Acronyms

ASTM	American Society for Testing and Materials
CFR	Code of Federal Register
CLP	Contract Laboratory Program
COD	Chemical oxygen demand
DOE	Washington State Department of Ecology
DOH	Washington State Department of Health
DQO	Data Quality Objectives
EC_{50}	Concentration which shows an effect on 50% of test organisms
EIS	Environmental Impact Statement
EWTP	Elwha Water Treatment Plant
IDW	Investigation Derived Waste
LC_{50}	Concentration which is lethal to 50% of test organisms
LOEC	Lowest observed effect concentration
mg/L	Milligram per liter
MS	Matrix spike
MSD	Matrix spike duplicate
NOEC	No effect concentration
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NTU	Nephelometric Turbidity Unit
PAC	Polyaluminum chloride
PAWTP	Port Angeles Water Treatment Plant
PPE	Personal protective equipment
PQL	Practical Quantitation Limit
PSWQA	Puget Sound Water Quality Authority
RCW	Revised Code of Washington
TOC	Total organic carbon
TC	Treatment Condition
TSS	Total Suspended Solids
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife

1.1 INTRODUCTION

The Elwha River Ecosystem and Fisheries Restoration Project includes the removal of two dams on the Elwha River near Port Angeles, Washington. The National Park Service (NPS) is responsible for removal of the dams and mitigation of impacts expected to result from the dam removal process. The Bureau of Reclamation (Reclamation) is providing technical support to the NPS and has contracted URS to design the Elwha Water Treatment Plant (EWTP). This facility will provide treated water for several users during the dam removal and sediment erosion period, which begins with the dam removal and is expected to last for three to five years.

1.2 SCOPE

This work plan outlines a testing program, which will be used to support several concepts associated with the design of the EWTP. There are three components to this testing program, consisting of the following:

- Generate residual solids and treated water samples for evaluation using formulated river water and bench-scale treatment process.
- Evaluate quality of residual solids, from bench-scale treatment process, using freshwater and marine sediment bioassays and chemical analyses.
- Evaluate quality of treated water, from bench-scale treatment process, using freshwater bioassays and chemical analyses.

The objective of this testing is to determine required doses of coagulant and pH adjustment chemicals and verify that the residual solids and the treated water will be non-toxic. This information will be used in selecting the coagulant and pH adjustment chemicals for use at the EWTP.

1.3 WORK PLAN CONTENTS

The work plan is organized as follows:

- Project organization
- Project background
- Previous investigations
- Investigation approach
- Data review, presentation, and interpretation
- Data management and reporting
- References

2.1 BUREAU OF RECLAMATION PROJECT MANAGER

Robert Hamilton P.E. is Reclamation's Contracting Officer's Representative. Mr. Hamilton is responsible for oversight of URS work on water quality mitigation activities related to the Elwha Project.

2.2 URS PROJECT MANAGER

Kris Turschmid P.E. is the URS project manager for the design of the EWTP. Mr. Turschmid is a Civil/Sanitary Engineer with extensive experience in water and wastewater treatment projects in the United States and Europe.

2.3 URS ENGINEER

Cameron Ochiltree P.E. is a design engineer for the EWTP. Mr. Ochiltree is a Civil/ Environmental Engineer with 6 years of experience in water and wastewater projects.

2.4 URS AQUATIC TOXICOLOGIST

Burt Shephard, is the aquatic toxicologist for the EWTP solids disposal evaluation. Mr. Shephard is a senior aquatic toxicologist with over 20 years experience evaluating the toxicity of chemical contaminants in surface water and sediment to aquatic biota.

2.5 URS QUALITY ASSURANCE MANAGER

Karen Mixon is the quality assurance manager for the EWTP bioassay and analytical testing. Ms. Mixon has 20 years of experience in analytical/environmental chemistry including 8 years of experience in an environmental testing laboratory and 8 years in the consulting field serving as a project chemist/quality assurance manager/field task manager on a wide variety of projects investigating groundwater, surface water, sediment, and soil chemical contamination.

2.6 URS HEALTH AND SAFETY MANAGER

Heather Boge is the health and safety manager for this testing program. Ms. Boge is an environmental scientist with 8 years of experience writing health and safety plans, risk assessments, and other technical reports, as well as performing field inspections and data management.

2.7 SUBCONTRACTORS

The proposed work will require the use of two subcontractor laboratories, a bioassay laboratory and a chemical analysis laboratory.

2.7.1 Bioassay Laboratory

A subcontracted laboratory will provide the bioassay laboratory services for this evaluation. This laboratory will be selected based on their response to a Request for Proposal that will be prepared by URS.

2.7.2 Chemical Analysis Laboratory

A subcontracted laboratory will provide the chemical analysis laboratory services for this evaluation. This laboratory will be selected based on their response to a Request for Proposal that will be prepared by URS.

2.8 SCHEDULE

The work described in this work plan will require approximately 14 weeks to complete. An approximate schedule for the testing activities is presented on Figure 2-1.

3.1 ELWHA RESTORATION PROJECT

The Elwha River Ecosystem and Fisheries Restoration Project will remove the Elwha and Glines Canyon Dams from the Elwha River to open up spawning areas for native resident and anadromous fish species that have been cut off since Elwha Dam was constructed in the mid-1910's. The approach proposed for removal of the dams will permit a gradual lowering of the water surfaces in the reservoirs. This approach will use the river's energy to erode the sediments, which have accumulated in the reservoirs since the dams were constructed, and transport this material downstream to the lower reaches of the river and the Strait of Juan de Fuca. The sediment erosion will result in periodic, high suspended solids concentrations in the river during the sediment erosion phase. The suspended solids concentrations are expected to exceed 500 mg/L for approximately 20% of the 5 year sediment erosion phase. The high suspended solids concentrations will adversely affect water quality for several downstream water users. The EWTP will be constructed to mitigate these impacts for several of the high-demand water users.

3.2 ELWHA WATER TREATMENT PLANT

The EWTP will be located along the Elwha River, adjacent to the existing Washington Department of Fish and Wildlife (WDFW) salmon-rearing channel. Figure 3-1 shows the location of the proposed EWTP. End users of the treated water include the following parties:

- WDFW salmon-rearing channel
- Lower Elwha Klallam Tribal hatchery
- Daishowa America paper mill
- Port Angeles water system, with supplemental treatment provided by the proposed Port Angeles Water Treatment Plant (PAWTP)

The maximum treated water demand from the EWTP will be approximately 52 million gallons per day. The plant will receive water from a new surface water intake located upstream on the Elwha River, and treat the water with a conventional coagulation and sedimentation process. The anticipated high suspended sediment concentrations in the river water will generate large volumes of residual solids, which will make traditional dewatering and disposal of the residual solids impractical. The conceptual EWTP design has been developed based on the understanding that the residual solids can be returned to the river during the dam removal and erosion period.

There are two major concerns with the proposed treatment process:

- The toxicity of coagulated sediments deposited in the freshwater and marine environments.
- The treated water quality.

These concerns will be addressed through this testing program.

3.3 REGULATORY STATUS

Federal and state laws and regulations related to the development of the EWTP are described below.

Section 402 of the federal Clean Water Act (33 USC 1642), implemented by 40 CFR Part 122, National Pollutant Discharge Elimination System (NPDES) program

The discharge of residual solids from the EWTP to the Elwha River will require an NPDES permit. Within Washington State, permits to discharge from point sources to surface water for federal agencies must be obtained from EPA Region 10. For nonfederal entities, the Washington State Department of Ecology (DOE) issues NPDES permits.

The permit will require that the discharge meet Washington State surface water quality standards at the outer boundary of the mixing zone, the size of which will be defined in the permit. The most significant water quality parameter in regard to this permit is turbidity, or total suspended solids (TSS). Washington's sediment and water quality standards are presented in the following paragraphs.

Water Quality Standards for Surface Waters of the State of Washington (Ch. 173-201A WAC)

Applying these regulations to the NPDES permit limits, turbidity in the Elwha River at the boundary of the mixing zone (not the discharge at the end of the pipe) must not exceed 5 NTU over background when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

If a discharge would cause an exceedance of a standard, the regulations allow a variance from the standards for an individual facility or stretch of water, provided certain conditions are met (WAC 173-201A-420). These conditions are the following:

- Modification to the water quality standard is consistent with the requirements of federal law (currently 40 CFR 131.10(g))
- The waterbody is assigned variances for specific criteria and all other applicable criteria are met
- Reasonable progress is being made towards meeting the original standard
- The variance is subject to a public and intergovernmental involvement process

A variance may be issued for up to 5 years and be renewed after providing for another opportunity for public and intergovernmental involvement and review.

Sediment Management Standards—Source Control (WAC 173-204-400)

The DOE has developed procedures for managing sources of sediment contamination. The procedures include evaluating the potential for a waste discharge to create a sediment impact by causing a violation of applicable sediment quality standards [WAC 173-304-400(1), (6)].

Given what is known about the chemistry of the sediments that will be discharged from the plant back into the Elwha River, it is unlikely that there is a potential for marine sediment contamination (no sediment quality or sediment cleanup standards have been promulgated for freshwater sediments). Specifically, there are no sediment quality or cleanup standards for iron and manganese, which are the only two chemicals mentioned as being of concern in *Elwha River Ecosystem Restoration Implementation, Draft Environmental Impact Statement* (NPS 1996).

4.1 LITERATURE REVIEW OF SEDIMENT REMOVAL

The coagulation and sedimentation process is a commonly used process for industrial and municipal water treatment. The process involves the addition of a coagulant to the incoming water stream, mixing of the coagulant and water, and settling of the coagulated solids. The process is effective for removal of suspended solids, and the normal effluent suspended solids concentrations for this type of process are typically in the range of 20-30 mg/L. Although the EWTP influent solids concentrations are higher than typically experienced, preliminary lab testing indicates that the process will still provide treated water total suspended solids (TSS) of approximately 20-30 mg/L.

4.2 WATER TREATABILITY INVESTIGATIONS

URS and Reclamation have previously conducted jar tests to evaluate the solids removal effectiveness of various coagulants including aluminum sulfate, polyaluminum chloride, and polyacrylamide. The preliminary tests indicated that a coagulation and sedimentation process will be able to provide acceptable treated water turbidity (less than 20 NTU) at high suspended solids concentrations.

4.3 TOXICITY STUDIES

Polyacrylamide Sediment Toxicity

A 48-hour sediment toxicity study is available that evaluated development and mortality of blue mussel embryos (*Mytilus galloprovincialis*) exposed to sediment collected from the reservoir behind Glines Canyon Dam on the Elwha River and combined with polyacylamide. The test was conducted in March 1999 by Northwestern Aquatic Sciences and Gathard Engineering and Consulting on behalf of the Lower Elwha Klallam Tribe. This study investigated the toxicity of sediments generated from a treatment process using Magnifloc 905-N (polyacrylamide) as a coagulant. The test was performed on three sediment samples: a laboratory control sediment untreated with the coagulant, a generated sediment sample treated with 10 mg/L of polyacrylamide, and a generated sediment sample treated with 300 mg/L of polyacrylamide. The results from the 10 mg/L sample indicated no statistically significant differences on the development or mortality of the test organisms relative to that in either the control sediment or the seawater control. The third sample (300 mg/L of polyacrylamide), however, experienced 46.6% abnormal development and mortality. Normally, the chemical concentration which shows either a lethal or other effect on 50% of the test organisms (LC_{50} or EC_{50}) value would be calculated using the results of this testing. Since a 50% effect level was not reached in any treatment, an LC_{50} value cannot be calculated based on this information. Interpretation of the test is limited to defining 10 mg/L polyacrylamide as a no effect concentration (NOEC), and 300 mg/L as the lowest observed effect concentration (LOEC). The available data does not allow for any meaningful interpretation of the effects of polyacrylamide on blue mussel larvae at concentrations between 10 mg/L and 300 mg/L coagulant. At this time, polyacrylamide is not being considered for use in the EWTP process.

Actiflo Effluent Water Column Toxicity

A series of whole effluent toxicity (WET) tests were conducted during the pilot testing of the ACTIFLO process proposed for the PAWTP. These tests were performed on the effluent from the ACTIFLO process (i.e., treated water). The WET test program included testing of three samples of ACTIFLO effluent and three samples of untreated well water. The tests were completed in accordance with method EPA-600-4-91-002 *Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms*, Method numbers : 1000.0 and 1002.0. The test organisms used were *Ceriodaphnia dubia* and *Pimphales promelas*. The results of this test indicate that the ACTIFLO effluent was not chronically toxic to the test organisms when compared to the well water. It is important to note that the Actiflo effluent is of a higher quality (i.e., lower TSS, iron, manganese and aluminum concentrations) than the treated water expected from the EWTP.

Alum Sediment and Water-Column Toxicity

There is an extensive amount of aquatic toxicology literature available on the toxicity of aluminum sulfate (alum) to freshwater aquatic species, and a limited amount of alum toxicity data for marine biota. A search of USEPA's AQUIRE database identified over 200 toxicity records when searching for the toxicity of alum defined as sulfuric acid, aluminum salt (3:2) or $Al_2(SO_4)_3$, CAS ID 10043-01-3. Most of the freshwater records are associated with studies of aluminum toxicity in acidified lakes and streams resulting from atmospheric acid deposition. The aquatic toxicity studies associated with acid deposition are performed at a pH lower than 6.5, in some cases as low as pH 4.0. Aluminum is much more toxic in acidic waters than it is in the circumneutral pH or basic conditions that will be maintained during coagulant studies for the EWTP. As toxicity of aluminum under acidic conditions is not germane to the present study, the toxicity of aluminum under acidic conditions literature will not be discussed further.

A number of other aquatic toxicity studies with alum are associated with its use to immobilize phosphorus in freshwater lake sediments, with the intent of reducing algal or macrophyte growth in the water column. Alum additions to lakes are commonly used to treat eutrophic conditions in lakes. These studies, some of which were performed under circumneutral or basic conditions, are summarized in the following paragraphs.

Alum water column toxicity data are available in the literature for *Ceriodaphnia dubia*, rainbow trout, and blue mussel. In general, residual aluminum concentrations below 0.05 mg/L are not expected to pose any threat of toxicity to any aquatic species under circumneutral pH conditions. For freshwater species, alum toxicity is observed at concentrations between 0.057 – 1000 mg/L. Fort and Stover (1995) found that in water of pH 7.0 – 7.3, the 48-hour LC_{50} for *C. dubia* ranges between 23.63 – 35.97 mg/L alum. Heming and Blumhagen (1988) found that 9.1 mg/L alum had no effect on rainbow trout survival after 48 hours at pH 8.7. Hunter et al. (1980) found that 50 mg/L alum was associated with 100% mortality of rainbow trout within 42 hours at pH 8.5. At pH 7.0, Hunter et al. (1980) found that 200 mg/L had no effect on rainbow trout survival in 10 days. A summary of field studies with alum treatments on benthic species, including *Chironomus* sp. is also available (Narf 1990). Narf (1990) found that alum treatment of lakes with alkalinities greater than 75 mg/L as $CaCO_3$ is not expected to have chronic or acute effects on benthic invertebrates.

The limited toxicity data available for marine species shows alum toxicity between 0.15 – 6,400 mg/L. Taneeva (1973) observed a 3-day LC_{50} of 2.55 mg/L alum to blue mussel (*Mytilus galloprovincialis*) larvae. For a different blue mussel species (*M. edulis*), Robinson and Perkins (1977) observed a 24-hour LC_{50} of 6,400 mg/L alum.

The objectives of the investigation are to generate samples that are representative of the residual solids and treated water from the proposed EWTP and to evaluate the properties of those samples using toxicity testing and chemical analyses. This section is divided into four subsections which present the data quality objectives, sediment testing, water testing, and sample collection and generation procedures. The data quality objectives subsection presents the process which is used to ensure that this testing program will generate data of appropriate quality for intended use. The sediment and water testing sections identify the tests to be performed on the collected/generated samples. The sample collection/generation section presents the procedures for collecting and generating the samples as well as the number and type of samples to be collected.

5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are quantitative and qualitative statements specified to ensure that data of appropriate quality are collected during field activities. The DQO process ensures that sufficient data are collected to make required decisions with a reasonable certainty and that only the minimum necessary data are collected.

The DQO process for the EWTP testing program described in this document is presented in Table 5-1.

Table 5-1
Data Quality Objectives Process

Step 1	
Problem statement	Insufficient data are available to determine whether treated water produced via coagulation of suspended solids from Elwha River water poses a threat of toxicity to aquatic species. Insufficient data are available to determine whether the coagulated sediments also pose a threat of toxicity to aquatic species after the sediments are returned to the Elwha River. Insufficient data are also available to identify the most efficient, least costly and least toxic coagulant for use with Elwha River water.
Identify team members	Section 2 of this work plan
Summarize the general problem	Existing site information is provided in Section 4 of this work plan. Section 3 of this work plan identifies the general site situation and the need for the studies described in this work plan
Identify the project schedule	Anticipate completion of the proposed field and laboratory work during the summer of 2003, with preparation of a report describing the results to follow. Figure 2-1 presents the proposed project schedule.
Project impacts	Impacts to the project from an engineering, biological and economic standpoint may be experienced due to delays in the selection of a coagulant, which will ultimately be used to remove suspended solids from river water. Toxicity may occur from coagulant associated with sediments proposed for return to the Elwha River, as well as residual coagulant in the produced water.
Step 2	
Decisions to be made	Collect data to identify the coagulant to be used to treat Elwha River water at the EWTP
	Use these data to evaluate coagulant toxicity to water column and sediment-dwelling aquatic species.
Issues to be resolved	Identify the coagulant to be used at EWTP, and its toxicity to aquatic species

Table 5-1 (cont.)
Data Quality Objectives Process

Step 3.	
Variables and action levels	Toxicity test interpretive guidelines are discussed in Section 7.4, with details presented in the individual toxicity test method protocol documents
Input decisions	Coagulant and toxicity test species to be evaluated
Step 4	
Study area description	The study area description is provided in Section 3 of this work plan
	A summary of existing data is provided in Section 4 of this work plan
Media of concern	Sediment released into the Elwha River after treatment at the EWTP, and water produced by the EWTP
Project schedule and constraints	The schedule for performance is presented in Figure 2-1.
Step 5	
Decision rules	Concentration of residual coagulant elicits no unacceptable levels of toxicity to aquatic species
Test of the hypothesis and decision error	Null Hypothesis: The precipitated sediment and produced water is non-toxic; has no effect on aquatic biota
	Alternative Hypothesis: The precipitated sediment and produced water is toxic; has adverse effects on aquatic biota
	False positive (F+) Type 1 Error: Decide that the precipitated sediment and produced water is toxic when in reality it is non-toxic, which results in additional evaluations and project modifications when none are required. This overreaction to a situation results in wasted resources, unnecessary expenditure and potentially unwarranted modifications to the EWTP.
	False negative (F-), Type II Error: Decide the precipitated sediment and produced water is non-toxic when it is toxic. This results in no action when additional testing was required. This situation allows a potential hazard to public health or environment to occur.
Step 6	
Specify the tolerable limits on decision errors	Discussion of required data quality is presented in the test acceptability criteria section of the bioassay test protocols
Determine the quantitaton limits of the error	Quantitation limits for the toxicity tests are in the test acceptability criteria portion of the toxicity test protocols
How much error is acceptable before the data becomes unusable	Discussion of required data quality is presented in the toxicity test protocols
Step 7	
Optimize the design for obtaining the data	The proposed sampling design is based on an evaluation of existing site data and the areas where data gaps exist. Section 4 provides a summary of the existing data. The plan is intended to answer questions regarding engineering feasibility, project costs, and hazards to the environment.

5.2 SEDIMENT TESTING

This section describes the tests that will be used to evaluate the properties of the residual solids generated by the EWTP. The tests will include sediment toxicity tests to determine whether the residual solids generated during water treatment are toxic to benthic and aquatic species, and chemical analyses to evaluate the physical and chemical properties of the residual solids. The general approach to the proposed toxicity testing is to utilize a suite of three freshwater and three marine sediment toxicity tests to quantify toxicity of the residual solids. The freshwater sediment testing will evaluate toxicity of residual solids discharged from the EWTP and deposited on the riverbed of the Elwha River. The marine sediment testing will evaluate toxicity of residual solids transported by the Elwha River and deposited in the Strait of Juan de Fuca. The chemical analyses will be performed to characterize the residual solids.

The toxicity tests to be performed are presented in Sections 5.2.1 and 5.2.2 and the chemical analyses are presented in Section 5.2.3.

5.2.1 Freshwater Sediment Toxicity Tests

This suite utilizes three freshwater sediment toxicity tests, two of which are commonly used in Washington in sediment toxicity monitoring programs. The tests, methods and sample volumes are presented in Table 5-2.

Table 5-2
Freshwater Sediment Toxicity Tests, Methods and Sample Volumes

Test	Method	Sample Volume Required (per test scenario)
Freshwater amphipod (*Hyalella azteca*) 10 day survival test	USEPA 2000	1 L
Insect larvae (*Chironomus tentans*) 10 day survival and growth test	USEPA 2000	1 L
Rainbow trout (*Oncorhynchus mykiss*) larvae 96 hour survival test	ASTM 1996	10 L

The *Hyalella azteca* and *Chironomus tentans* tests are commonly used in freshwater sediment monitoring programs in Washington. The rainbow trout test was selected because rainbow trout is the salmonid species most commonly used in toxicity testing in North America, making it an appropriate test species for the Elwha Dam removal project, one of whose primary objectives is to restore anadromous salmonid populations to the Elwha River.

5.2.2 Marine Sediment Toxicity Tests

This suite utilizes three sediment toxicity tests commonly used to evaluate compliance with Washington's Sediment Management Standards in marine and estuarine waters. The tests, methods and sample volumes are presented in Table 5-3.

Table 5-3
Marine Sediment Toxicity Tests, Methods and Sample Volumes

Test	Method	Sample Volume Required (per test scenario)
Marine amphipod (*Ampelisca abdita*)10 day survival test	USEPA and PSWQA 1995	2.5 L
Marine polychaete (*Neanthes arenaceodentata*) 20 day growth test	USEPA and PSWQA 1995	2.5 L
Blue mussel (*Mytilus edulis*) larval 48 hour survival/abnormality test	USEPA and PSWQA 1995	1 L

The residual solids are expected to have a very high fines content. It has been shown that one of the commonly used marine amphipods in bioassays with Puget Sound sediments, *Rhepoxynius abronius*, exhibits reduced survival in sediments with greater than about 60% fines. The reduced survival of *R. abronius* occurs in high fine content sediments even in the absence of any chemical contaminants in the sediment. Both *Ampelisca abdita* and *Eohaustorius estuarius* should be suitable test species with the anticipated fines content of the produced sediment. Salinity in most of the Strait of Juan de Fuca exceeds 30%, except for nearshore areas with freshwater inputs. This is slightly above the salinity range of 2 – 28% recommended for use in *E. estuarius* toxicity tests. *A. abdita* is therefore recommended as the amphipod species for testing with the produced sediments as indicated in Table 5-3.

5.2.3 Sediment Chemical Analyses

This section describes the chemical analyses to be performed on the residual solids produced from the water treatment process. The objective of the chemical analyses is to identify the general characteristics of the residual solids used in the sediment toxicity tests. The testing will include parameters that are likely to indicate significant changes to sediment chemistry due to the addition of coagulants through the treatment process.

Sediment samples will be collected and submitted to an offsite laboratory for analytical testing for total metals (aluminum, calcium, iron, magnesium, and manganese), chemical oxygen demand (COD), total organic carbon (TOC), and total solids. The methods and criteria for each testing parameter are indicated in Table 5-4.

Table 5-4
Sediment Analytical Program and Quality Assurance Objectives

Analytical Parameter	Analytical Methodology	Practical Quantitation Limit (PQL)[1]	Completeness (%)	Control Limits Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	
				Accuracy % Recovery	Precision RPD
Total Metals (mg/kg)					
Aluminum	EPA SW-846 6010B	50-250	90	75-125	<20
Calcium	EPA SW-846 6010B	50-250	90	75-125	<20
Iron	EPA SW-846 6010B	50-250	90	75-125	<20
Magnesium	EPA SW-846 6010B	50-250	90	75-125	<20
Manganese	EPA SW-846 6010B	1-5	90	75-125	<20
Conventional Analyses					
COD (mg/kg)	EPA 410.4	10	90	75-125	<20
TOC (mg/kg)	EPA 415.1	1-3	90	75-125	<20
Total Solids (%)	EPA 160.2	-	90	NA	NA

[1] PQLs shown as ranges as the testing laboratory has not been selected.

The analytical methods and associated QA/QC procedures were selected based on consideration of the project objectives. The analytical methods, calibration procedures, QC measurements and criteria are based on current analytical protocols contained in the USEPA documents *Test Methods for Evaluating Solid Waste*, SW-846, *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, and *Standard Methods for the Examination of Water and Wastewater*, 18th and 19th editions.

5.3 WATER TESTING

This section describes the tests that will be used to evaluate the properties of the treated water generated by the EWTP. The tests will include freshwater toxicity tests to determine whether the treated water from the EWTP will be toxic to aquatic species and chemical analyses to evaluate the physical and chemical properties of the residual solids. The general approach to the proposed toxicity testing is to utilize a suite of three freshwater toxicity tests to quantify toxicity of the treated water. Quantifying the toxicity, if any, of the treated water to freshwater aquatic species is an objective of this study because the treated water will be used as influent water to the WDFW salmon-rearing channel and the Lower Elwha Klallam Tribal hatchery. The chemical analyses of the water are important to the hatcheries and the PAWTP and Daishowa facilities because the analyses will provide the users with the chemical characterization of the treated water.

The toxicity tests to be performed are presented in Section 5.3.1 and the chemical analyses are presented in Section 5.3.2.

5.3.1 Freshwater Water Column Toxicity Tests

This suite of three toxicity tests will evaluate treated water effects on fish survival, zooplankton survival and reproduction, and bacterial survival and growth. The tests, methods and sample volumes are presented in Table 5-5.

Table 5-5
Freshwater Water Column Toxicity Tests, Methods and Sample Volumes

Test	Method	Sample Volume Required (per test scenario)
Rainbow trout 96 hour acute toxicity test	USEPA 2002a	20 L
Ceriodaphnia dubia three brood (7-8 day) survival and reproduction test	USEPA 2002b	1 L
Microtox® bacterial luminesence test	USEPA and PSWQA 1995	0.5 L

5.3.2 Water Chemical Analyses

This section describes the chemical analyses to be performed on the water produced from the water treatment process. The objectives of the chemical analyses are to identify the parameters needed to fully characterize the treated water and to provide a reference for comparison between the treated water characteristics with the corresponding water column toxicity test results.

Samples will be collected from each of the batches of treated water prepared for the bioassay testing. The samples will be tested for parameters that are likely to indicate significant changes to water chemistry due to the addition of coagulants through the treatment process. Changes in water chemistry may impact the suitability of the water for use at downstream facilities.

Water samples will be collected and submitted to an offsite laboratory for analytical testing for total and dissolved metals (aluminum, calcium, iron, magnesium, and manganese), hardness, alkalinity, chloride, COD, sulfate, TOC, and TSS. Additionally, field parameters will be collected at the time of sample collection and will include pH, turbidity, temperature, and specific conductance. The methods and criteria for each testing parameter are included in Table 5-6.

Table 5-6
Water Analytical Program and Quality Assurance Objectives

Analytical Parameter	Analytical Methodology	Practical Quantitation Limit (PQL)[2]	Completeness (%)	Control Limits (MS/MSD)	
				Accuracy % Recovery	Precision RPD
Total and Dissolved Metals (µg/L)					
Aluminum	EPA SW-846 6010B	50-250	90	75-125	<20
Calcium	EPA SW-846 6010B	50-250	90	75-125	<20
Iron	EPA SW-846 6010B	50-250	90	75-125	<20
Magnesium	EPA SW-846 6010B	50-250	90	75-125	<20
Manganese	EPA SW-846 6010B	1-5	90	75-125	<20
Conventional Analyses (mg/L)					
Alkalinity [1]	SM 2320	1	90	75-125	<20
Chloride	EPA 300.0 or 325.2	0.25-1	90	75-125	<20
COD	EPA 410.4	10	90	75-125	<20
Hardness	EPA 6010 Calc	NA	90	75-125	<20
Sulfate	EPA 300.0 or 375.2	1-3	90	75-125	<20
TOC	EPA 415.1	1-3	90	75-125	<20
TSS	EPA 160.2	1	90	NA	NA
Field Tests					
pH	Field (Horiba U-22 or similar)	NA	NA	NA	NA
Specific Conductivity	Field (Horiba U-22 or similar)	NA	NA	NA	NA
Temperature	Field (Horiba U-22 or similar)	NA	NA	NA	NA
Turbidity	Hach Turbidimeter	NA	NA	NA	NA

[1] Includes total, carbonate, and bicarbonate components.
[2] PQLs shown as ranges as the testing laboratory has not been selected.

The analytical methods and associated QA/QC procedures were selected based on consideration of the project objectives. The analytical methods, calibration procedures, QC measurements and criteria are based on current analytical protocols contained in the USEPA documents *Test Methods for Evaluating Solid Waste*, SW-846, *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, and *Standard Methods for the Examination of Water and Wastewater*, 18th and 19th editions.

5.4 SAMPLE COLLECTION AND GENERATION

The sample collection and generation process is divided into five steps, consisting of the following:

- Collect untreated water and sediments
- Determine optimum coagulant doses
- Generate residual solids and treated water samples
- Collect samples and transport to bioassay and chemical analysis laboratories
- Dispose of investigation derived waste materials

These steps are described in detail in the following subsections.

5.4.1 Untreated Sediment and Water Sample Collection

Surface Water Collection

Surface water will be collected from the Industrial Channel adjacent to the WDFW salmon-rearing channel at the proposed EWTP site. Water will be collected using a submersible pump. The pump will supply water needed to prepare the formulated river water samples for generation of residual solids and treated water samples. The pump will be suspended in the water column to prevent disturbance of channel sediments. The water will be collected as needed to minimize water storage requirements.

Untreated Sediment Collection

The untreated sediments will be collected from Lake Aldwell (the reservoir above Elwha Dam on the Elwha River). Divers will collect the sediments from the bottom of the reservoir using 6-inch diameter, 12-inch long plastic tubes. The tubes will be manually pushed into the sediments, and once full, a cap will be installed on the open end of the tube. This collection strategy is intended to minimize the water content of the samples by avoiding disturbance of the in-situ sediments. Once the samples are brought to the surface, the sediments will be kept immersed in water to maintain an anaerobic environment. The samples will be processed by homogenization of cores in five gallon plastic buckets partially filled with river water using stainless steel utensils. Once the sediments are homogenized, the buckets will be held in water ice until the sediments are needed for testing.

5.4.2 Chemical Dose Determinations

Samples will be tested in the lab to determine the required coagulant (sedimentation aid) and sodium hydroxide (pH adjustment) dosages at the low and high ends of the anticipated plant solids concentration range. Two coagulants are included in this analysis: aluminum sulfate (alum) and polyaluminum chloride (PAC) with a polymer. Multiple polymers may be tested and the most effective will be used for the generation of the test samples. The coagulant (and polymer) doses will be evaluated using a jar testing procedure. In addition to the coagulants, the required sodium hydroxide doses will be determined through laboratory titrations. The combined chemicals will be tested in the laboratory using a jar testing procedure to determine the optimum doses for generation of the samples.

Laboratory Procedure for Coagulation

Two solids conditions, 500 and 40,000 mg/L TSS, will be simulated and tested in a jar testing procedure. The testing will be performed using a four station gang jar stirrer with the procedure outlined below.

1. Prepare the formulated water, which will represent river water under the anticipated solids conditions, by mixing untreated river water with untreated sediments from Lake Aldwell to achieve the required TSS concentration (either 500 or 40,000 mg/L TSS).
2. Measure the pH and turbidity of formulated water.
3. Fill four 1-L jars with 500-ml of formulated water per jar.
4. Use gang jar stirrer to rapidly mix formulated water at 200 rpm for 30 seconds while adding the test dose of sodium hydroxide.
5. Measure pH.
6. Continue to use gang jar stirrer to rapidly mix formulated water at 200 rpm for an additional 30 seconds while adding the test dose of coagulant (and polymer if appropriate) to each jar.
7. Continue 200 rpm mix for 30 seconds.
8. Slowly mix each jar at 20-30 rpm for 60 seconds.
9. Transfer the jar contents into a 1 L volumetric cylinder carefully to minimize disruption of the floc particles.
10. Allow solids to settle for 30 minutes.
11. Measure the pH and turbidity of the supernatant in the cylinder.
12. Measure the total water volume and sludge volume in the cylinder.

The tests will include a minimum of one jar test for each solids condition and each of the two coagulants. Each jar test will have four stations where the coagulant concentration will be varied. Table 5-7 lists the parameters of a series of jar tests that will be performed, but additional tests may be required based on initial test results. Table 5-8 is an example of the test record that will be used to record jar test results.

Table 5-7
Jar Test Parameters

Test No.	Solids (mg/L)	Coagulant	Coagulant Dose (mg/L)	Polymer	Polymer Dose (mg/L)
1a	500	Alum	2	NA	NA
1b	500	Alum	4	NA	NA
1c	500	Alum	6	NA	NA
1d	500	Alum	8	NA	NA
2a	40,000	Alum	130	NA	NA
2b	40,000	Alum	140	NA	NA
2c	40,000	Alum	150	NA	NA
2d	40,000	Alum	160	NA	NA
3a	500	PAC	.5	Polymer A	TBD
3b	500	PAC	1	Polymer A	TBD
3c	500	PAC	2	Polymer A	TBD
3d	500	PAC	3	Polymer A	TBD
4a	40,000	PAC	18	Polymer A	TBD
4b	40,000	PAC	22	Polymer A	TBD
4c	40,000	PAC	26	Polymer A	TBD
4d	40,000	PAC	30	Polymer A	TBD

Table 5-8
Jar Test Record

Test No.	Initial Turbidity (NTU)	Initial pH	pH Adjustment (concentration/volume)	Effluent Turbidity (NTU)	Sludge Volume/ Formulated Water Volume (ml/ml)	Treated Water pH

Laboratory Procedures for pH Adjustment

The treatment process will include pH adjustment to produce effluent with a pH of approximately 7.2. A pH target of 7.2 has been selected to maintain the pH slightly above neutral and protect against coagulant toxicity which occurs under acidic conditions. To estimate the chemical requirements for pH adjustment, titration curves will be developed using the procedure outlined below.

1. Prepare a 500-ml formulated water solution containing 500 mg/L TSS by mixing untreated river water with untreated sediments from Lake Aldwell.

2. Pipette 100-ml of the formulated water solution into a beaker, place pH probe in beaker, and begin mixing.
3. Using a burette, add incremental volumes of sodium hydroxide to the beaker and record the pH. Continue until the pH reaches an observable endpoint. Complete the procedure three times.
4. Repeat the procedure with solutions containing 2,000, 10,000 and 40,000 mg/L TSS.
5. Repeat steps 1 through 3 with the addition of each coagulant (at the optimum dose, as determined through the jar testing procedure) in step 2 at 500 and 40,000 mg/L TSS.
6. Prepare titration curves for sediment solutions and the sediment and coagulant solutions.

5.4.3 Residual Solids and Treated Water Sample Preparation

The residual solids and treated water samples will be prepared to simulate the treatment scenario with the greatest anticipated chemical dosages. The treatment scenario assumes influent water with 40,000 mg/L TSS.

Five coagulant doses will be used to generate residual solids and treated water for each of the two coagulants (i.e., 10 test conditions total). The coagulant dose scenarios will include the optimum dose, one suboptimal dose (50% of optimum), and three excess doses (150%, 200%, and 300% of optimum). The optimal coagulant dose is defined as the coagulant concentration added to formulated water that best removes suspended solids with a minimum quantity of coagulant, and will be determined based on the results of the jar testing procedure as described in Section 5.4.2. The suboptimal coagulant dose (i.e., coagulant added provides incomplete treatment), and three excess coagulant doses (i.e., excess coagulant is carried with treated water and coagulated sediments) will be prepared to represent potential operating problems and to determine the effects of such problems.

Sample Preparation

The apparatus will include an 80-gallon tank. The tank will have a conical bottom with a port located on the floor of the tank and ports located at 6 inch intervals along the tank wall. The samples will be prepared using a batch procedure as follows:

1. In an 80 gallon tank, add river water and sediment to produce approximately 50 gallons of a solution with 40,000 mg/L TSS.
2. Add the coagulant to the required solution concentration (as defined in work described in Section 5.1.1).
3. Add the required sodium hydroxide to obtain a target pH of 7.2.
4. Mix the contents of the tank with a mechanical mixer for 2 minutes (mixing time may vary depending on the mixing intensity of the mixer used).
5. Allow the contents of the tank to settle for approximately 30 to 120 minutes (settling time may vary depending on initial results).
6. Using the sidewall ports, remove the treated water until the water surface is six inches above the solids/water interface. Retain approximately 26 L of the treated water for chemical

analyses and toxicity testing. Store the water sample in accordance with the requirements presented in Section 5.4.4.

7. Using the floor port, remove the sludge layer to the sludge water interface. Retain approximately 20 L of the residual solids for chemical analyses and toxicity testing. Store the residual solids in accordance with the requirements presented in Section 5.4.4.
8. Discard the remaining contents in the tank in accordance with the requirements presented in Section 5.4.5.
9. Prepare composite samples of both the residual solids and the treated water in accordance requirements presented in Section 5.4.4.
10. Repeat the procedure to obtain the required volumes for each of the 10 test conditions.

The required sample volumes will provide adequate sediment and water for both the toxicity testing and chemical analyses. The total residual solids and treated water sample volumes will be 200 L, and 260 L, respectively. The required volume of untreated sediment will be approximately 450 L to allow for initial dose determinations and untreated sediment reference samples. The corresponding volume of untreated water will be approximately 2,800 L.

5.4.4 Sample Collection and Transport

Composite residual solids and treated water samples will be prepared for each test condition. The samples will be homogenized by stirring the full sample volume (water or solids) using stainless steel utensils. Once homogenized, the samples will be divided among the containers to be submitted for toxicity testing and chemical analysis. In addition to the residual solids and treated water, untreated sediment and water samples will be used as reference for the toxicity tests. This will be used to determine whether the untreated sediments and water elicit toxic responses in test organisms. This is very important because the failure to recognize that the untreated sediment or water is toxic could result in incorrectly assigning any observed toxicity in the treated water samples to the coagulant. Laboratory control water and sediment will also be used as negative controls for each toxicity test.

Field duplicate samples will be collected at a ratio of 1 per 20 samples collected for chemical analysis. In addition, one decontamination water rinsate blank will be collected for each type of non-dedicated sampling equipment used. The field duplicates will be analyzed for the same tests as the parent sample. Rinsate blanks, if collected, will be analyzed for metals only.

Chemical analysis samples will be collected and stored using the recommended sample containers, preservatives and holding times identified in Table 5-9. Bioassay samples will be shipped in 5-gallon polyethylene carboys placed in shipping coolers. The holding time for the bioassay samples will not exceed 8 weeks. Samples will be labeled and shipped to the laboratories in coolers containing water ice.

Table 5-9
Water Sample Containers, Preservatives and Holding Times

Analyses	Method	Container	Preservative	Holding Time
Metals	EPA SW846 6010B	1-liter or 500-ml polyethylene bottle	4°C, HNO_3 to pH < 2	6 months
Alkalinity	SM 2320	1-500 ml polyethylene bottle	4°C, No headspace	14 days
Total Organic Carbon	EPA 415.1	1-250 ml amber glass	4°C, H_2SO_4 to pH<2	ASAP/14 days
Sulfate, Chloride	See Table 5-6	1-500 ml polyethylene bottle	4°C	28 days
Chemical Oxygen Demand	EPA 410.4	1-250 ml amber glass	4°C, H_2SO_4 to pH<2	28 days
TSS	EPA 160.2	2-1 L polyethylene bottles	4°C	7 days

Tables 5-10 and 5-11 present a summary of the samples to be collected and the tests to be performed.

Table 5-10
Sediment Testing Summary

Test	Sample Size (L)	Sample/Test Scenario											
		Alum					PAC + Polymer					Reference Samples	
		Optimum Dose	0.5xOptimum	1.5xOptimum	2.0xOptimum	3.0xOptimum	Optimum Dose	0.5xOptimum	1.5xOptimum	2.0xOptimum	3.0xOptimum	Untreated Water	Untreated Sediment
Freshwater Sediment Bioassay Testing													
Freshwater amphipod (*Hyalella azteca*) 10 day survival test	1	x	x	x	x	x	x	x	x	x	x		x
Insect larvae (*Chironomus tentans*) 10 day survival and growth test	1	x	x	x	x	x	x	x	x	x	x		x
Rainbow trout (*Oncorhynchus mykiss*) larvae 96 hour survival test	10	x	x	x	x	x	x	x	x	x	x		x
Marine Sediment Bioassay Testing													
Marine amphipod (*Ampelisca abdita*)10 day survival test.	2.5	x	x	x	x	x	x	x	x	x	x		x
Marine polychaete (*Neanthes arenaceodentata*) 20 day growth test	2.5	x	x	x	x	x	x	x	x	x	x		x
Blue mussel (*Mytilus edulis*) larval 48 hour survival/abnormality test	1	x	x	x	x	x	x	x	x	x	x		x
Chemical Analyses													
Total Metals (Aluminum, Calcium, Iron, Magnesium, and Manganese)	0.5	x	x	x	x	x	x	x	x	x	x		x
Total Organic Carbon	0.25	x	x	x	x	x	x	x	x	x	x		x
Chemical Oxygen Demand	0.25	x	x	x	x	x	x	x	x	x	x		x
Total Solids	0.25	x	x	x	x	x	x	x	x	x	x		x
Sediment Sample Volume per Scenario (L)	**19.25**												

Table 5-11
Water Testing Summary

Test	Sample Size (L)	Sample/Test Condition											
		Alum					PAC + Polymer					Reference Samples	
		Optimum Dose	0.5xOptimum	1.5xOptimum	2.0xOptimum	3.0xOptimum	Optimum Dose	0.5xOptimum	1.5xOptimum	2.0xOptimum	3.0xOptimum	Untreated Water	Untreated Sediment
Freshwater Water-Column Bioassay Testing													
Rainbow trout 96 hour acute toxicity test	20	X	X	X	X	X	X	X	X	X	X	X	
Ceriodaphnia dubia three brood (7-8 day) survival and reproduction test	1	X	X	X	X	X	X	X	X	X	X	X	
Microtox® bacterial luminesence test	0.5	X	X	X	X	X	X	X	X	X	X	X	
Chemical Analyses													
Total Metals (Aluminum, Calcium, Iron, Magnesium, and Manganese)	1	X	X	X	X	X	X	X	X	X	X	X	
Total Dissolved Metals (Aluminum, Calcium, Iron, Magnesium, and Manganese)	1	X	X	X	X	X	X	X	X	X	X	X	
Alkalinity	0.5	X	X	X	X	X	X	X	X	X	X	X	
Total Organic Carbon	0.25	X	X	X	X	X	X	X	X	X	X	X	
Sulfate and Chloride	0.5	X	X	X	X	X	X	X	X	X	X	X	
Chemical Oxygen Demand	0.25	X	X	X	X	X	X	X	X	X	X	X	
Total Suspended Solids	1	X	X	X	X	X	X	X	X	X	X	X	
Water Sample Volume per Scenario (L)	26												

5.4.5 Investigation-Derived Waste

Investigation-derived waste (IDW) will be generated during sample collection and the residual solids and treated water generation. IDW will include residual solids, treated water, personal protective equipment (PPE) like nitrile gloves, and solid waste (tubing, plastic bags and containers, filters). Based on current knowledge of site media and chemicals intended for use in this study, IDW is not likely to be designated as hazardous waste. PPE and solid waste will be bagged in plastic garbage bags for disposal at a municipal landfill. Residual solids will be dewatered, contained, and disposed at a municipal landfill. Treated water will be discharged to the industrial pipeline, which feeds the Daishowa paper mill.

6.1 DATA REVIEW

6.1.1 Residual Solids and Treated Water Sample Preparation

URS staff will prepare a laboratory report for the chemical dose determinations and residual solids and treated water sample preparation. The URS Quality Assurance Manager will review the laboratory reports to ensure that the tests met the specified data quality objectives and test acceptability criteria. Test acceptability criteria for these procedures will be primarily based on repeatability of results.

6.1.2 Bioassay Laboratory Quality Assurance

URS will review the bioassay laboratory reports to ensure that the tests as performed met data quality objectives and test acceptability criteria. Test acceptability criteria for the individual bioassay procedures are normally found in the methods manual for each test. Adherence to test acceptability criteria for each individual toxicity test procedure will be a contractual requirement for the bioassay laboratory. Additional test acceptability criteria for sediment and surface water toxicity tests are found in USEPA and USACE (1998), and will be used if necessary for tests that do not have acceptability criteria within the methods manual.

6.1.3 Chemical Analysis Laboratory Quality Assurance

A URS chemist will review the chemical analytical laboratory data submitted by the laboratory as well as field measurements. Data will be reviewed to assess that the analyses were performed correctly and that the data are acceptable and meet the project data quality objectives.

Data Validation - Chemical Analyses

Data validation reviews will be performed and reviewed by the URS Quality Assurance Manager for all laboratory analysis. The following guidelines will be used for data validation reviews of all analyses performed during the investigation:

- *Test Methods for Evaluating Solid Waste*, SW-846, USEPA
- USEPA *Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94-013, February 1994, where appropriate
- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020
- *Standard Methods for the Examination of Water and Wastewater*, 18th Edition, 1992 and 19th edition, 1995

The components of all data validation reviews will include the following items:

- Holding Time
- Initial and Continuing Calibrations
- System Performance
- Method Blanks

- Matrix Spike/Matrix Spike Duplicates
- Field Duplicates
- Compound Identification
- Compound Quantification
- Reported Detection Limits

Data will be reviewed and validated based on the QA/QC criteria specified for each method in addition to the evaluation of holding times, instrument calibrations, method blanks, field duplicates, and analyte quantitation and reported detection limits. If required, data qualifiers will be assigned based on the definition of qualifiers used in the EPA Contract Laboratory Program (CLP).

Analytical data generated in the field will be reviewed. The data will be reviewed for adherence to standardization procedures, sample preparation, calculations, and final recording. Data will be initialed and dated by the URS Quality Assurance Manager. Additional data validation memoranda will not be generated for field analysis.

A summary validation will be performed on all data generated by the laboratory. A summary data validation review refers to conducting reviews that involve evaluating only the data summary and QA/QC summary sheets provided with all data packages. The summary reviews do not involve spot-checking the raw data packages and calculations.

If summary reviews indicate potential problematic areas within a data set, a standard data validation review may be conducted. A standard data validation review refers to conducting a data validation review that requires spot-checking the laboratory's raw data package and calculations in accordance with the EPA Functional Data Validation Guidelines (USEPA 1999, 2002). The URS Quality Assurance Manager will contact the laboratory to discuss the problematic areas; however, if questions still exist, the URS Quality Assurance Manager may elect to conduct a standard review of the data.

Field QA/QC Sample Evaluation

Following the data validation reviews of each set of analytical data, field QA/QC sample results will be evaluated. Field QA/QC sample results will provide information regarding the potential for introducing artificial contaminants during the sample collection process, cross-contamination and field variability. If the introduction of contaminants is evident due to problems with sample containers, sample collection procedures and/or sampling equipment, the URS Quality Assurance Manager will notify the Project Manager. The URS Quality Assurance Manager will provide recommendations to implement sampling procedural changes to rectify the problem prior to additional sample collection efforts. Upon approval by the Project Manager, procedural changes will be documented. The Project Manager will notify the Reclamation of the procedural changes.

6.2 DATA PRESENTATION

The report to Reclamation will identify the coagulant that elicits the least toxicity to freshwater and marine species. In support of this identification, the report to Reclamation will contain summary tables of the results of all sediment and surface water toxicity test results, and narrative that provides an interpretation of the results. Although the absence of toxicity is a major factor in selecting the coagulant to be used to treat Elwha River water, toxicity is but one of several factors that will be evaluated during the selection process for a coagulant. Other factor include treatment effectiveness and chemical cost.

6.3 DATA INTERPRETATION

6.3.1 Treatment Efficiency Evaluation

The treatment efficiency evaluation will include the methodology and results related to the coagulant and pH dose optimization. Appendices will include the laboratory treatment evaluation data and compiled results.

6.3.2 Toxicity Evaluation

The toxicity evaluation will include the testing methodology, analysis, and results. Each toxicity test has its own species-specific interpretive criteria that are presented in the test protocol guidance documents identified in Sections 5.2.2 (freshwater sediment), 5.2.3 (marine sediment), and 5.3.2 (freshwater water-column). Toxicity test results are normally reported in a statistically reduced manner. Specifically, calculations are made to estimate either the coagulant concentration associated with 50% mortality of the test species during the duration of the test (LC_{50}), or, if the test endpoint is growth or reproduction, the concentration of coagulant associated with a 50% effect (either increase or reduction) on the test endpoint (EC_{50}). These calculations are usually made with software available from USEPA or commercially (e.g., Toxstat).

Most toxicity test results undergo statistical significance evaluations that determine whether an observed effect is statistically and biologically significant. These significance tests are performed by comparing results of the test organisms exposed to coagulants with the results of laboratory controls and reference area organisms exposed to surface water and sediment without coagulant additions. Results of these statistical comparisons are reported using two endpoints: a statistically significant difference from the control organism result, and an absolute magnitude response of the test organism. Bioassay results are not considered to show a biologically or statistically significant effect unless both a statistically significant difference in responses is observed between the test and the control organisms, and a minimum absolute magnitude biological response is observed. The minimum absolute biological response criteria varies with species and toxicity test protocol, but are normally found as part of the test acceptability criteria published as part of the test protocol.

The reason that both statistical significance and a minimum absolute response must be observed before a toxicity test is considered to show an adverse effect of a toxicant is that in some cases, no control organisms show a response, whereas one or two test organisms show the response. Statistical significance of test results is often observed in this case, where the biological response in the above example would not translate to an observed adverse effect in the environment.

As one example of this approach, the growth of the marine polychaete *Neanthes arenaceodentata* is not considered to be biologically reduced from that of controls unless growth is less than 70% of the growth of control organisms during the 20-day exposure period. Even if there is a statistically significant decline in growth at the end of a Neanthes test, the sediment is not considered to be adversely affecting growth unless both a statistically significant decline in growth and growth less than 70% that of controls is observed. Test interpretive guidelines for each bioassay are found in their respective test protocol guidance documents.

It is possible that few or no adverse effects will be observed in some of the toxicity tests. In this case, one or two additional summary statistics can be calculated. These are the lowest observed adverse effect level (LOAEL) and the no observed adverse effect level (NOAEL). The LOAEL is the lowest test concentration associated with a statistically and biologically significant increase (or decrease) in test organism response to the coagulant. The NOAEL is the highest concentration that has no statistically and biologically detectable effect on organism response to coagulants.

6.3.3 Chemical Analysis Evaluation

The chemical analysis evaluation will include the test methodology used, the analytical results, field measurements, and results of the data review. Appendices will include copies of the laboratory reports and the data review memoranda.

7.1 RESIDUAL SOLIDS AND TREATED WATER GENERATION DATA

Residual solids and treated water generation data and results will be documented in laboratory reports prepared by URS staff while completing this work. Laboratory reports will describe the methods and results of the testing, as well as any variances from test protocols.

7.2 BIOASSAY TEST LABORATORY DATA

Laboratory bioassay results will be submitted in one or more reports by the contracted toxicity testing laboratory. Laboratory reports are expected to be stand alone documents that describe the methods and results of the toxicity tests, as well as any variances from test protocols. The toxicity test reports from the bioassay laboratory will be appended to the URS report to Reclamation. Bioassay reports from the bioassay laboratory will include statistical summaries and reductions of the toxicity data. The required statistical presentations and summaries are described in Section 7.4.

7.3 CHEMICAL ANALYSIS LABORATORY DATA

Chemical results will be submitted in one or more reports by the contracted analytical testing laboratory. The reports will contain all necessary information to confirm the data has been generated per the requested method and that the results reported are correct. The laboratory reports will be appended to the URS report to Reclamation.

7.4 REPORTING OF RESULTS

A Treatment Evaluation Report will be prepared to summarize the results of the treatment, toxicity and chemical analyses and provide recommendations regarding chemical selection for the EWTP. The report will include sections describing the various components of the testing program. The report sections will include the following:

- Field procedures
- Treatment efficiencies evaluation
- Sediment toxicity testing results
- Sediment chemical analyses results
- Water toxicity testing results
- Water chemical analyses results
- Recommendations

Field procedures will identify variances from the work plan related to sample collection, sample preparation or similar. The treatment efficiencies evaluation will include descriptions of the coagulants tested, laboratory observations, and optimum doses for the coagulants. Results of the lab testing will be compiled in an appendix to the report.

Results of the bioassay testing for both the sediments and the water will be summarized in the body of the report. Appendices will include the raw chemical and biological response data for the bioassay, as well as the results of all statistical calculations. All statistical calculations performed to identify significant differences in test organism responses between controls and generated samples will be performed by the bioassay laboratory as part of their report submitted to URS.

Analytical chemistry results for both sediments and water will be statistically summarized in the main body of the report. Laboratory reports to URS will be compiled in an appendix to the report. These statistical summaries will include the number of samples, the minimum, maximum and arithmetic mean detected concentrations. No statistical tests of differences in results among the different doses tested will be performed. Nor will any comparisons of the analytical results be made to surface water or sediment quality criteria, standards or guidelines.

Recommendations will consider the required coagulant doses and associated bioassay testing and chemical analysis results to determine the most appropriate coagulant for use at the EWTP. Bioassay considerations will include the relationship between the optimum dose effect and the estimated dose that shows a negative effect (i.e., LC_{50}, EC_{50}, or LOAEL).

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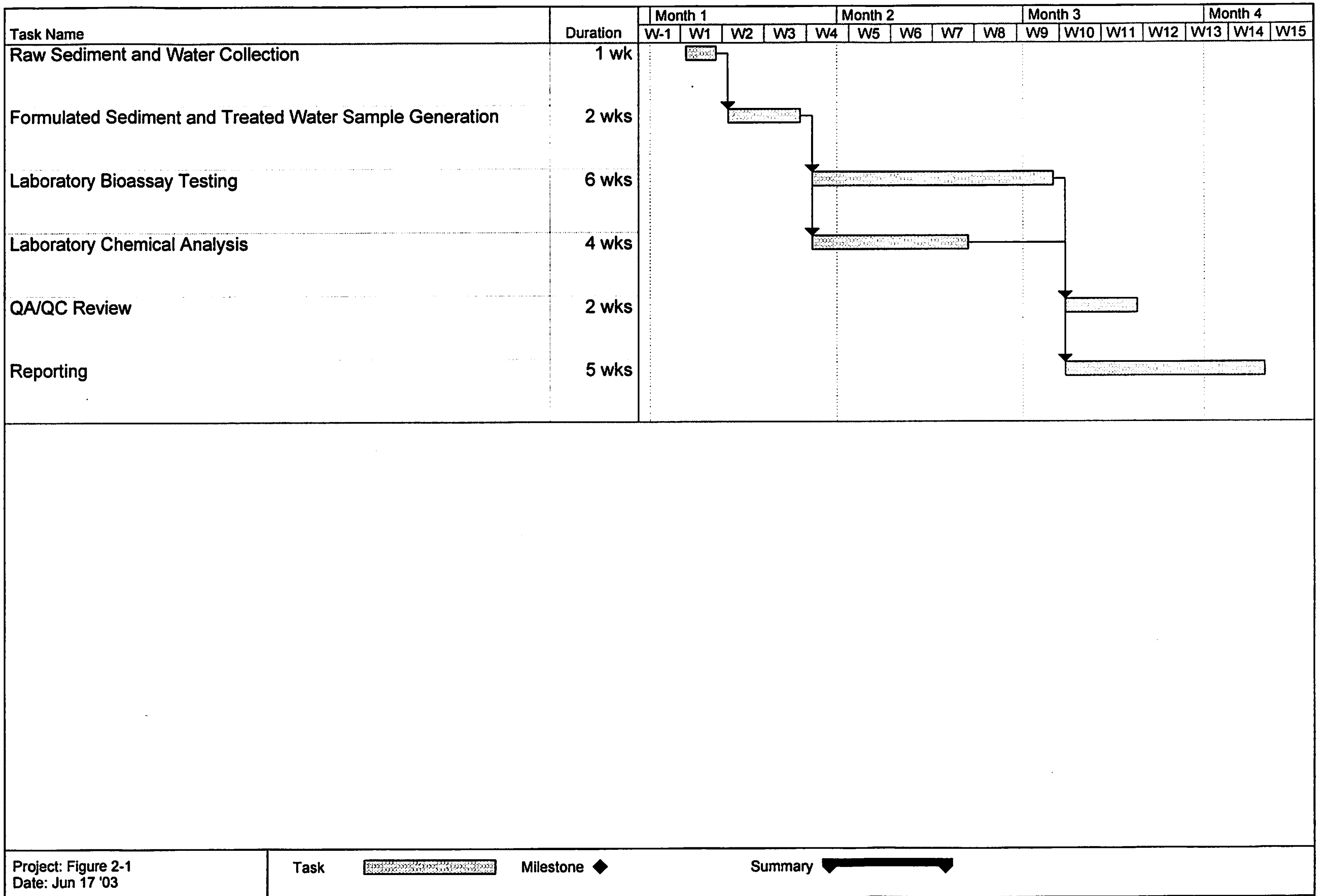
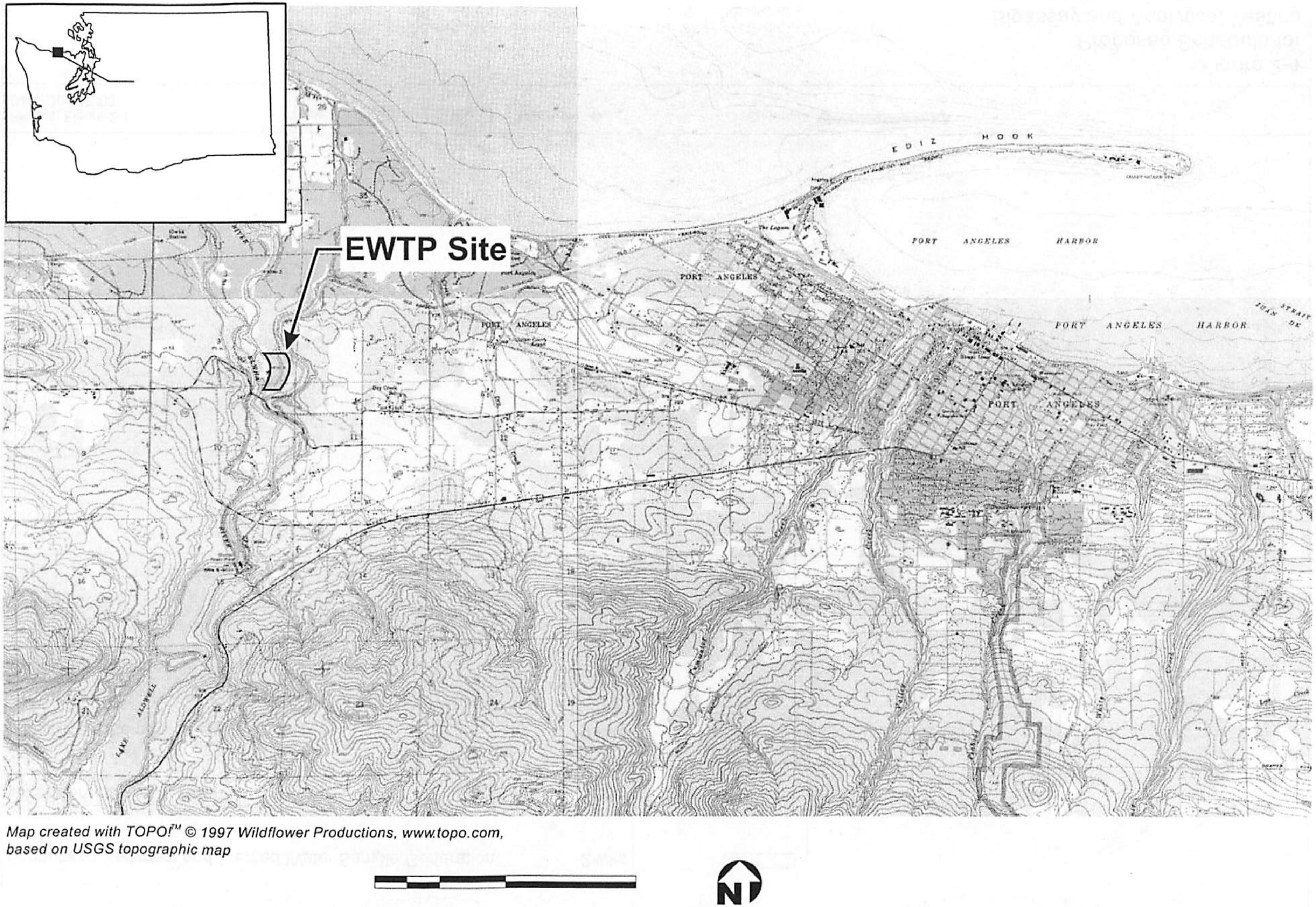


Figure 2-1
Proposed Schedule for
Bioassay and Analytical Testing



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